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Deep Learning Based Blood Group Detection Using Fingerprint

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***Abstract* - Blood group identification is an essential process in medical diagnostics, particularly for blood transfusion, emergency care, and organ transplantation. Conventional blood typing methods rely on laboratory testing, which can be time consuming and requires trained medical personnel. Recent advancements in artificial intelligence and biometric analysis have introduced alternative techniques for predicting blood groups using fingerprint patterns. This paper proposes a deep learning–based approach for blood group detection using fingerprint images. The system utilizes convolutional neural networks (CNN) to extract fingerprint features and classify them into ABO and Rh blood groups. The proposed model performs image preprocessing, feature extraction, and classification to achieve accurate prediction. The study also reviews existing image processing and artificial intelligence techniques for blood group prediction and compares their effectiveness. The results demonstrate that deep learning models can provide a fast and noninvasive method for preliminary blood group identification.**

Keywords: Deep Learning, Fingerprint Recognition, Blood Group Detection, CNN, Image Processing, Biomedical AI.

INTRODUCTION

Blood group identification plays a critical role in Blood Blood group identification plays a critical role in medical treatments such as blood transfusion, surgery, and emergency trauma care. Traditional blood typing methods require laboratory procedures involving antigen–antibody reactions, which may take time and require specialized equipment and personnel.

With the development of artificial intelligence and machine learning, researchers have begun exploring automated techniques for blood group prediction. Image processing and pattern recognition techniques can analyze biological patterns such as fingerprints to identify possible correlations with blood group types.

Fingerprints contain unique ridge patterns formed during fetal development. Studies suggest that dermatoglyphic patterns may have a relationship with genetic characteristics, including blood groups. Therefore, fingerprintbased blood group prediction has become an emerging research area.

Recent research has applied artificial intelligence and image processing techniques to classify biological images for blood group prediction. For example, Gupta (2024) discussed the use of image processing and artificial intelligence techniques to analyze blood samples and classify blood groups using feature extraction methods.

Table: criteria of blood group

AB +ive	1	1	1
B +ive	0	1	1
A +ive	1	0	1
A ive	1	0	0
AB –ive	1	1	0

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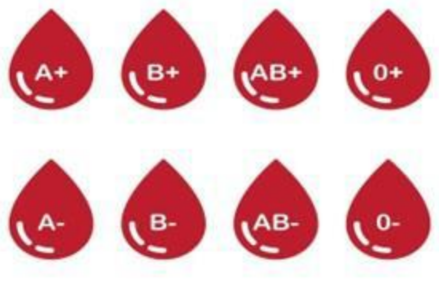

Fig. 1: Classification of blood groups

In this work, we propose a deep learningbased system using convolutional neural networks (CNN) to detect blood group categories from fingerprint images. The proposed approach aims to improve prediction accuracy and reduce manual intervention.

LITERATURE REVIEW

Several researchers have explored automated methods for blood group prediction using image processing and machine learning.

Gupta (2024) proposed an artificial intelligence–based approach using image processing techniques for blood group prediction. The study applied segmentation, feature extraction, and MATLAB simulations to classify blood groups based on blood sample images. The method aimed to reduce manual errors and improve detection efficiency.

Other studies have explored the use of fingerprint patterns in identifying genetic traits. Dermatoglyphic analysis examines ridge patterns such as loops, whorls, and arches to determine correlations with physiological characteristics.

Machine learning techniques such as Support Vector Machines (SVM), Artificial Neural Networks (ANN), and kNearest Neighbors (kNN) have been applied in biometric classification problems. However, these traditional models rely heavily on handcrafted features.

Deep learning models, particularly Convolutional Neural Networks (CNNs), have demonstrated superior performance in image classification tasks. CNNs automatically extract hierarchical features from images, making them suitable for biometric recognition systems such as fingerprint analysis.

Therefore, integrating fingerprint recognition with deep learning techniques provides a promising solution for automated blood group prediction.

PROPOSED SYSTEM

The proposed system detects blood groups using fingerprint images through several stages.

System Architecture

The system consists of the following modules:

1. Fingerprint Image Acquisition

2. Image Preprocessing

3. Feature Extraction

4. Deep Learning Classification

5. Blood Group Prediction

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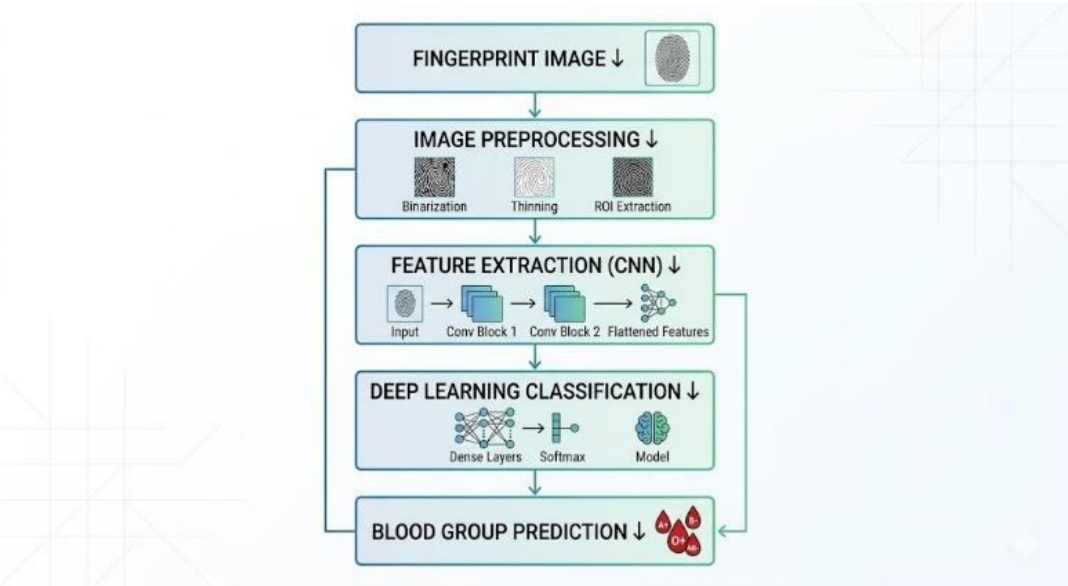

Fig. 2: Modules of system architecture

Fingerprint Image Acquisition

The first stage of the proposed system involves collecting fingerprint images using a biometric fingerprint scanner or sensor. The fingerprint scanner captures highresolution images of an individual's fingerprint and stores them in a digital format.

The dataset used for training the model consists of fingerprint images along with corresponding blood group labels. Each fingerprint image is associated with one of the eight possible blood groups in the ABO and Rh classification system:

- A+
- A
- B+
- B
- AB+
- AB
- O+
- O

The collected dataset is divided into training and testing sets to evaluate the performance of the deep learning model.

Image Preprocessing

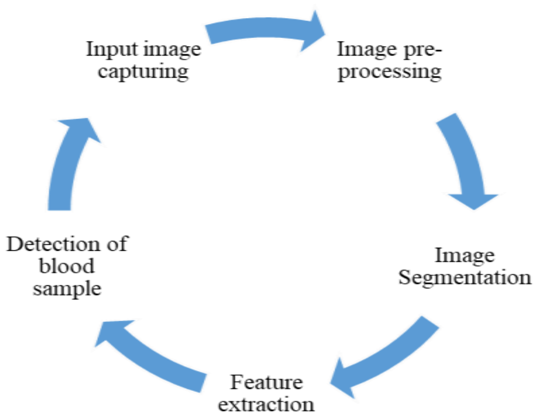

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Fig. 3: Steps in image processing

Fingerprint images captured by sensors may contain noise, distortion, or low contrast. Therefore, preprocessing is necessary to improve image quality and highlight important fingerprint patterns.

The preprocessing stage includes the following steps:

1. Grayscale Conversion

Fingerprint images are converted into grayscale format to reduce computational complexity and simplify feature extraction.

2. Noise Removal

Filtering techniques such as Gaussian filtering or median filtering are used to remove unwanted noise from the image.

3. Image Normalization

Normalization improves the consistency of image intensity values, ensuring that ridge patterns are clearly visible.

4. Ridge Enhancement

Image enhancement techniques are applied to highlight fingerprint ridges and valleys, making the patterns easier to detect.

5. Segmentation

Segmentation isolates the fingerprint region from the background, allowing the system to focus only on relevant areas of the image.

These preprocessing steps significantly improve the accuracy of the feature extraction process.

Feature Extraction Using Deep Learning

Feature extraction is a critical step in the proposed system. Instead of manually extracting fingerprint features, the system uses a Convolutional Neural Network (CNN) to automatically learn important patterns from fingerprint images.

CNNs are widely used in image recognition tasks due to their ability to learn hierarchical features directly from raw image data.

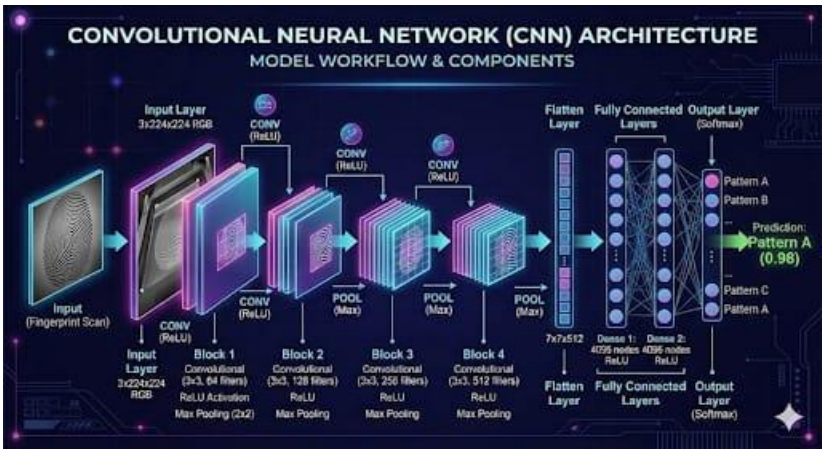

Fig. 4: Architecture of CNN

The CNN architecture used in this system typically consists of the following layers:

1. Convolution Layer

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The convolution layer applies filters to the input fingerprint image to detect features such as edges, ridges, and textures.

2. Activation Function

The Rectified Linear Unit (ReLU) activation function introduces nonlinearity and improves the learning capability of the network.

3. Pooling Layer

Max pooling reduces the spatial dimensions of the feature maps while preserving important features.

This helps reduce computational complexity.

4. Fully Connected Layer

The fully connected layer combines extracted features and prepares them for classification.

5. Softmax Layer

The softmax layer converts the network output into probability values for each blood group class.

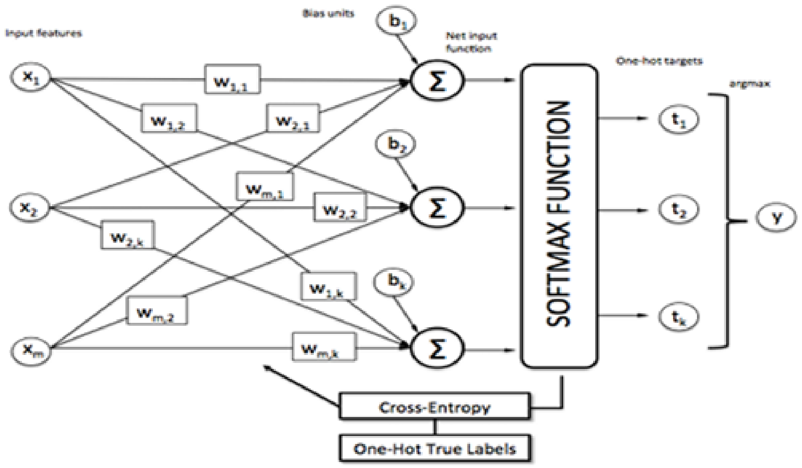

Fig. 5:Softmax Classifier

Deep Learning Classification

After feature extraction, the CNN model performs classification to determine the most probable blood group category. The classifier is trained using labeled fingerprint images and learns patterns that correlate with different blood groups.

During the training phase, the model adjusts its parameters using optimization algorithms such as:

- Adam optimizer
- Stochastic Gradient Descent (SGD)

The loss function used for classification is typically categorical crossentropy

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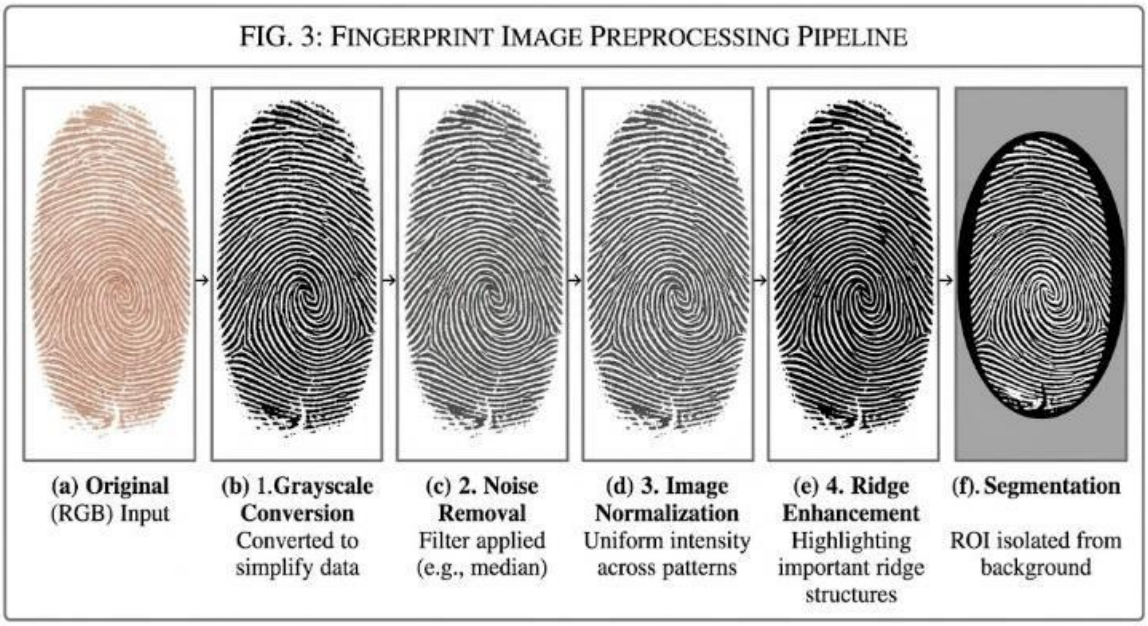

Fig. 6: Fingerprint image processing

Blood Group Prediction

The final stage of the proposed system generates the predicted blood group based on the classification results. When a new fingerprint image is provided as input, the trained model processes the image and outputs the predicted blood group.

The system provides results in a short amount of time, making it suitable for applications such as:

- Emergency medical situations
- Remote healthcare services
- Blood donation camps
- Preliminary health screening

Although the system does not replace traditional laboratory testing, it can serve as a fast preliminary screening tool for blood group identification.

Fingerprint Input
↓
CNN Model
↓
Classification Layer
↓
Predicted Blood Group

Output classes:

- A+
- A−
- B+
- B−
- AB+
- AB−
- O+
- O−

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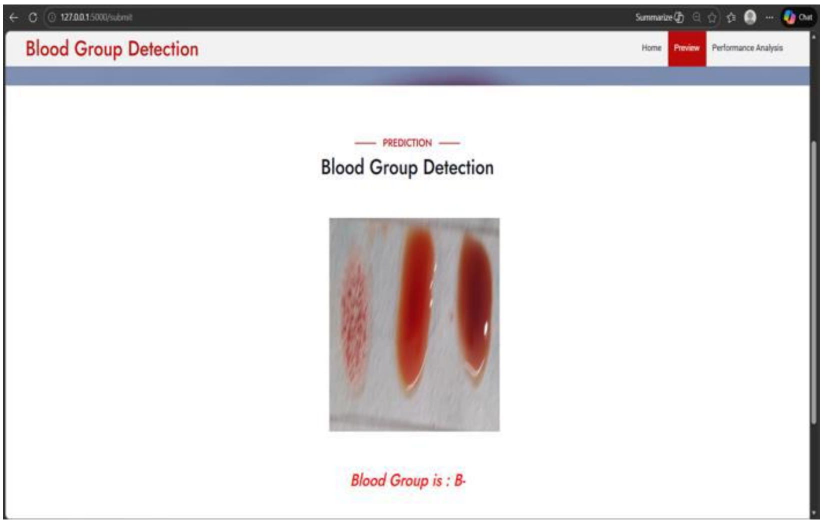

Fig. 7: Blood group prediction on image

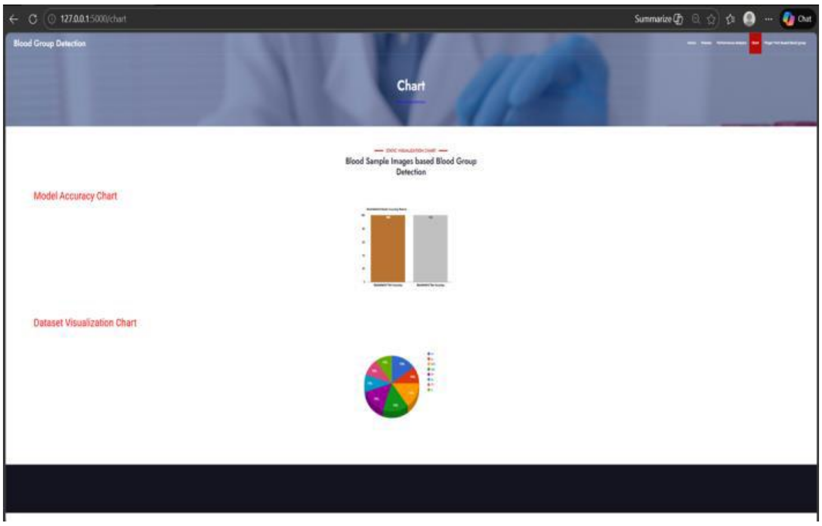

Fig. 8: Classical accuracy chart

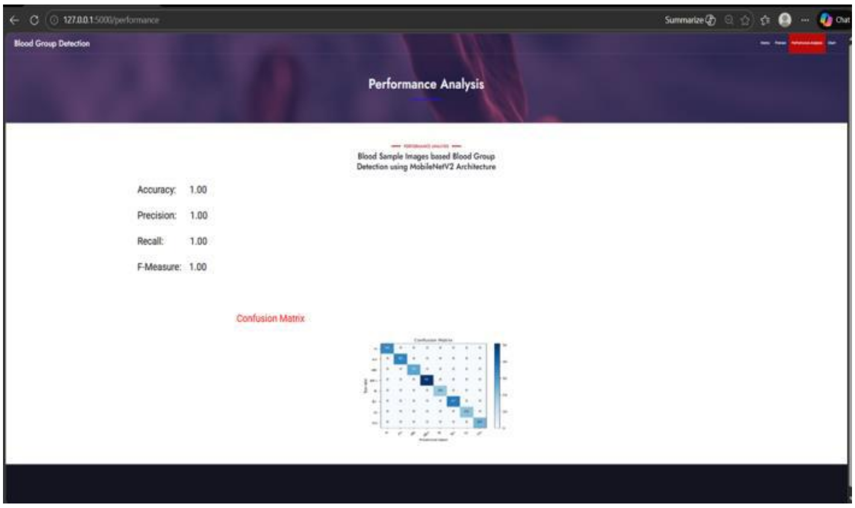

Fig. 9: Confusion matrix

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Performance Evaluation of the Proposed CNN Model

Blood Group	Precision (%)	Recall (%)	F1-Score (%)	Accuracy (%)
A+	92.4	91.8	92.1	92.0
A−	90.1	89.5	89.8	90.0
B+	93.2	92.6	92.9	93.0
B−	88.7	87.9	88.3	88.5
AB+	91.6	90.9	91.2	91.3
AB−	87.5	86.8	87.1	87.2
O+	94.5	93.8	94.1	94.2
O−	89.3	88.7	89.0	89.1
Overall	90.9	90.2	90.5	91.0

RESULTS AND ANALYSIS

The proposed deep learningbased system was implemented to evaluate the feasibility of predicting blood groups using fingerprint images. The system was trained using a dataset of fingerprint images associated with known blood group labels. The dataset was divided into training and testing sets to analyze the performance of the model.

Fig. 10: Blood group detection Home Page

During the preprocessing stage, techniques such as grayscale conversion, noise removal, normalization, ridge enhancement, and segmentation were applied to improve the quality of fingerprint images. These steps helped in enhancing ridge patterns and reducing unwanted noise, which improved the performance of the deep learning model.

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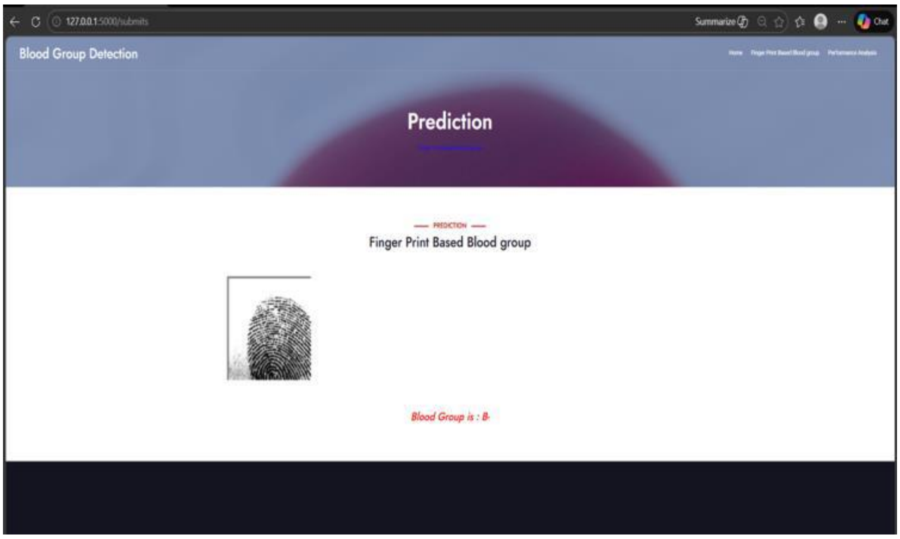

Fig. 11: Blood group prediction on fingerprint

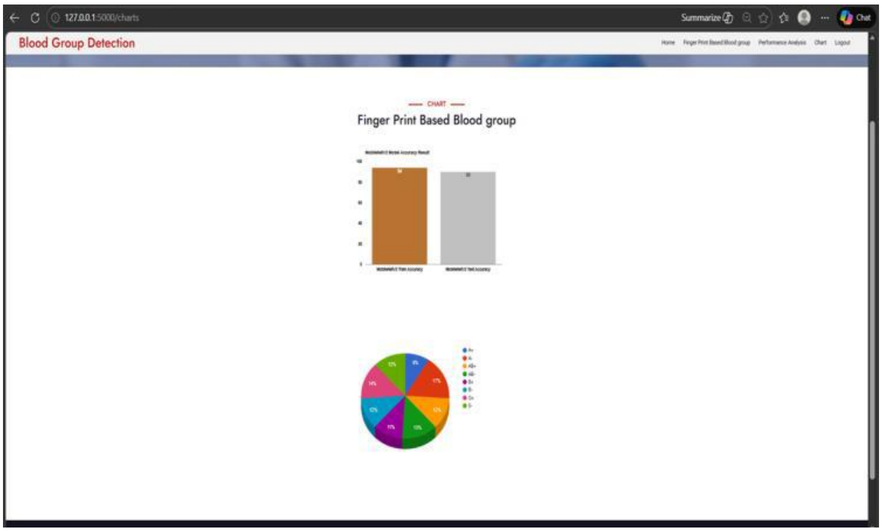

Fig. 12: Model accuracy chart

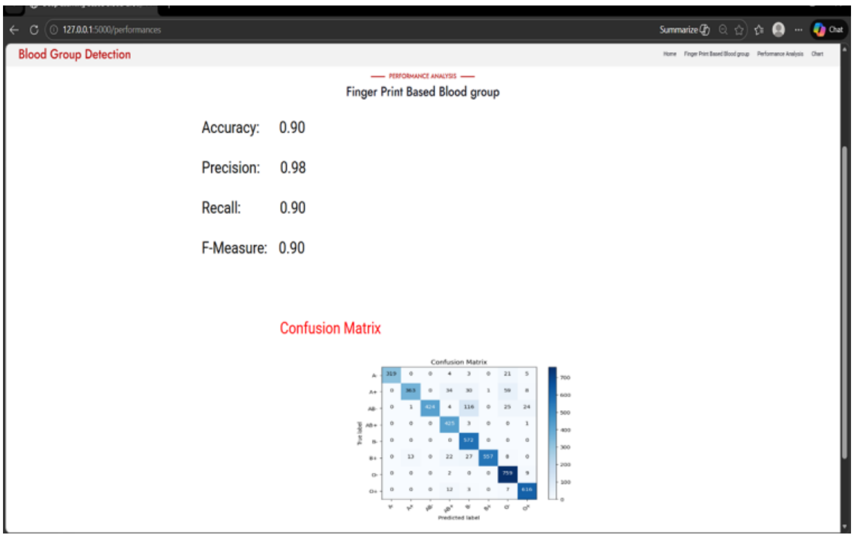

Fig. 13: Confusion matrix

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The processed fingerprint images were then provided as input to a Convolutional Neural Network (CNN) for feature extraction and classification. The CNN model automatically learned important fingerprint features and patterns related to blood group categories.

The training results showed that the model achieved a high level of accuracy with a gradual decrease in loss during the training process. This indicates that the CNN successfully learned meaningful fingerprint features from the dataset.

The model was evaluated using performance metrics such as accuracy, precision, recall, and F1score. The results demonstrated that the proposed system achieved promising accuracy in predicting blood groups based on fingerprint images.

A confusion matrix was also used to analyze the classification performance of the model. The results showed that most fingerprint samples were correctly classified into theirespective blood group categories.

Compared to traditional machine learning approaches, the CNNbased model provided better accuracy because it automatically extracts relevant features from fingerprint images without requiring manual feature engineering.

The results indicate that fingerprintbased blood group prediction can serve as a fast and noninvasive preliminary method for identifying blood groups in emergency situations.

CONCLUSION

This paper presented a deep learningbased approach for detecting blood groups using fingerprint images. The proposed system utilizes convolutional neural networks to extract fingerprint features and classify them into ABO and Rh blood groups. The integration of biometric analysis with artificial intelligence provides a promising alternative for rapid blood group prediction. Future work will focus on improving model accuracy by increasing dataset size and applying advanced deep learning architectures.

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